forest management note

Note No. 45 Northern Forestry Centre Edmonton, Alberta

CONSTANTS FOR CALCULATING FUEL LOADS IN ALBERTA

A knowledge of downed-dead roundwood fuel is of general interest to forest managers and environmental scientists. In fire management and research, the interest is quite specific (e.g., assessing fire hazard, evaluating resistance to fireguard construction, or formulating prescribed burning prescriptions). The line intersect method (Van Wagner 1968) is generally accepted as the most practical means of sampling wood fuel volumes and weights. In practical terms, the two principal formulas for calculating downed-dead roundwood fuel loads according to the diameter size class scheme of the Canadian Forestry Service fire research group (McRae et al. 1979; Van Wagner 1982a) are as follows:

$$W = \frac{kn(QMD)^2Gac}{NL} \quad [1]$$

$$W = \frac{k\Sigma d^2Gac}{NL} \quad [2]$$

where W = fuel load (t/ha); k = 1.234, the constant to convert roundwood volume to a weight per unit area basis; n = number of intercepts per roundwood diameter size class; $(QMD)^2$ = squared quadratic mean diameter for intercepted roundwood ≤7.0 cm in diameter (cm^2); Σd^2 = sum of the squared diameters for intercepted roundwood >7.0 cm in diameter (cm^2); G = specific gravity of roundwood according to diameter size class and/or degree of decay; a = correction factor for nonhorizontal angle of roundwood pieces (1.13 for roundwood ≤7.0 cm in diameter (Brown and Roussopoulos 1974) or 1.00 for roundwood >7.0 cm in diameter (Brown 1974); c = slope correction factor, which is $\sqrt{(1 + (\%\ \text{ground slope}/100)^2)}$; N = number of fuel sampling transects; and L = length of fuel transect (m). Equation 1 is used to calculate the weight of various size classes of downed-dead roundwood fuels ≤7.0 cm in diameter; Equation 2 is used to calculate the weight of roundwood pieces >7.0 cm in diameter.

To calculate roundwood fuel loads, the main requirement is to have representative QMD and G values by cover type or tree species, diameter, and in some instances, relative stage of decomposition. Quadratic mean diameter values can be derived by experimental sampling (McRae 1982) or by graphical means (Van Wagner 1982b). The remaining values required to complete the computations are either determined by field sampling (N, d, and c) or are preselected by the user (k, N, L).

This study was limited to pure stands of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.), white spruce (*Picea glauca* (Moench) Voss), and trembling aspen (*Populus tremuloides* Michx.) in the Montane zone of Jasper National Park (Rowe 1972; Holland and Coen 1982). Working in the vicinity of Jasper townsite, Delisle (1986) determined G and experimental QMD values for these species as part of a much larger study of fuel description. The average QMD values for downed-dead fuel size classes ≤7.0 cm in diameter are summarized in Table 1. These QMD values are based on 100 samples per size class per species. Mean G values for these smaller diameter fuels are summarized by tree species and size class in Table 2. The mean G values for downed-dead roundwood fuels >7.0 cm in diameter are summarized in Table 3. A minimum of 30 samples per species per size class was used to develop the mean G values listed in Tables 2 and 3.

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Table 1. Quadratic mean diameters for downed-dead roundwood fuels ≤7.0 cm in diameter by species and size class

Roundwood diameter class[a] (cm)	Quadratic mean diameter (cm)			
	Douglas-fir	Lodgepole pine	White spruce	Trembling aspen
0.0–0.5	0.275	0.336	0.313	0.338
0.5–1.0	0.682	0.697	0.711	0.669
1.0–3.0	1.692	1.910	1.807	1.814
3.0–5.0	3.894	3.884	3.796	3.909
5.0–7.0	5.862	5.925	5.903	5.872

[a] For those who prefer to use a diameter size class of 0.0–1.0 cm, the quadratic mean diameters are 0.520, 0.547, 0.550, and 0.530, respectively.

Table 2. Mean specific gravities for downed-dead roundwood fuels ≤7.0 cm in diameter by species and size class

Roundwood diameter class[a] (cm)	Mean specific gravity			
	Douglas-fir	Lodgepole pine	White spruce	Trembling aspen
0.0–0.5	0.4800	0.4413	0.4753	0.5084
0.5–1.0	0.5763	0.4823	0.5523	0.4781
1.0–3.0	0.5472	0.4793	0.5841	0.3958
3.0–5.0	0.5000	0.4763	0.5338	0.4045
5.0–7.0	0.4955	0.4330	0.4683	0.4316

[a] For those who prefer to use a diameter size class of 0.0–1.0 cm, the mean specific gravities are 0.5290, 0.4621, 0.5138, and 0.4932, respectively.

Table 3. Mean specific gravities for downed-dead roundwood fuels >7.0 cm in diameter by species and condition[a]

Roundwood condition	Mean specific gravity				
	Douglas-fir	Lodgepole pine	White spruce	Trembling aspen	Composite conifer[b]
Sound	0.5212	0.4657	0.4336	0.4192	0.4678
Rotten	0.4492	0.4108	0.3950	0.3613	0.4078

[a] Based on samples between 7.0 and 17.0 cm in diameter.
[b] Values based on Douglas-fir, lodgepole pine, and white spruce sample data.

Please note that the G values presented in Table 3 are based on samples between 7.0 and 17.0 cm in diameter. Also, the composite conifer values presented in Table 3 should only be used when it is impossible to distinguish the species of the material. The sampling techniques used and the statistical reliability of the results presented here are thoroughly discussed by Delisle (1986).

The genetic character of the four tree species studied and the environment in which they are found are considered to be similar throughout low-elevation forests of Alberta's East Slopes (Strong and Leggat 1981). We therefore believe that the QMD and G values presented here are applicable to similar sites outside of the study area. Further research is needed to assess the variability in QMD and G values over the full range of conditions. At present, this Note documents the best available information.

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